KRUEGER MIDDLE SCHOOL
Fighting Falcons
438 Lanark Drive San Antonio, TX 78218 Telephone: 650-1350 Fax: 650-1374

Critical Design Review

Vehicle and Payload Experiment Criteria

I) Summary of CDR

Team Summary

Krueger School of Applied Technologies—Krueger Middle School
438 Lanark Drive
San Antonio, TX 78218
Lead Teachers:
    Russell Claughton, Tracy Thomas
Mentors:
    Payload—Kevin Marafioto
    Rocket— Bill Wagner
    Safety—William Casteel
    Website— Rita Garza, Josh Beck

Launch Vehicle Summary

Size: 78” Length x 4” Diameter
Motor Choice: J135
Recovery System: We will be using a dual deployment recovery system on our rocket to minimize mistakes and to make sure that our rocket is fully recovered. Our rocket will be launching to reach the optimum altitude at 5280 feet.
Rail Size: 1x1 with ¼” launch pins (model rocket will use 1/4” launch lug)

Payload Summary

Our scientific experiment is to sample the concentration of ozone levels comparing ground ozone level to that of the ozone level one mile high in two different locations.

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II) Changes made since PDR

Highlight all changes made since the proposal and the reason for those changes.

- Changes made to Vehicle Criteria
  The total rocket length is now 78.8 inches instead of 83 inches to make it more compatible with the payload. We are also changing the Motor to a J135W. Until we finish the rocket system and get the final product mass we can only go on simulated data. Using RockSim the J135W will come the closest to hitting the desired altitude.

- Changes made to Payload Criteria
  There have been no changes made since the PDR.

- Changes made to Activity Plan
  We have started a new website. The address is:
  http://www.neisd.net/ksat/sli.html
  We have also been invited to teach a rocketry lesson to 5th graders at Longs Creek Elementary School during their Science Day Program on March 28th.

III) Vehicle Criteria
Design and Verification of Launch Vehicle

- **Flight Reliability confidence**

  - The students and staff have been building model rockets for several years. The Mark Twain rocket design has been used successfully as part of our after school High K program.
  - The initial flight test of the Mark Twain Scale Model has proven that the Mark Twain is capable of stable flight.

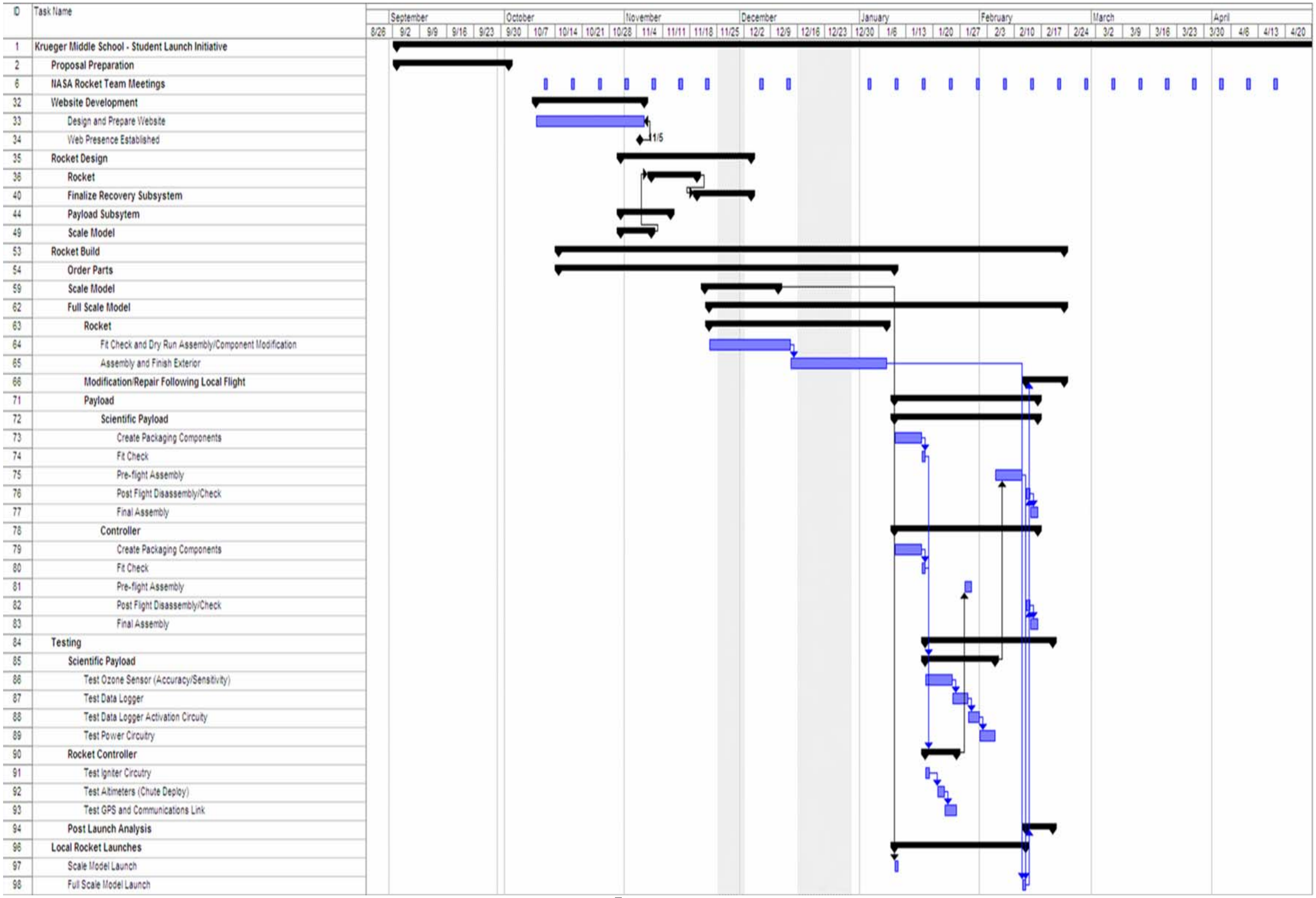
- **Mission Statement, Requirements, and Mission Success Criteria**

  A. Mission Statement: The Krueger SLI team will launch a rocket a mile high and sample the ozone concentration at various altitudes during descent. Once the data is recovered it will be compared with ground level concentration.

  B. Requirements: It requires an eight (8) month commitment to successfully design, construct, test, launch, and recover a reusable rocket and science payload. The initiative is more involved than designing and building a rocket from a commercial kit. It involves diverse aspects such as: scheduling, purchasing, performing calculations, financing the project, coordinating logistics, arranging press coverage, and documenting impact made on education through reports and design reviews. Teams are encouraged to involve a diverse group of departments such as mathematics, science, technology, English, journalism, and art.

  C. Success Criteria: If the Krueger SLI rocket goes the required height (one mile), is recovered relatively undamaged, and if the team is able to retrieve readable data then, and only then, can the mission be declared a success.

- **Major Milestone Schedule(Project Initiation, Design, Manufacturing, Verification, Operations, and Major Reviews)**



Major Milestones Schedule cont.

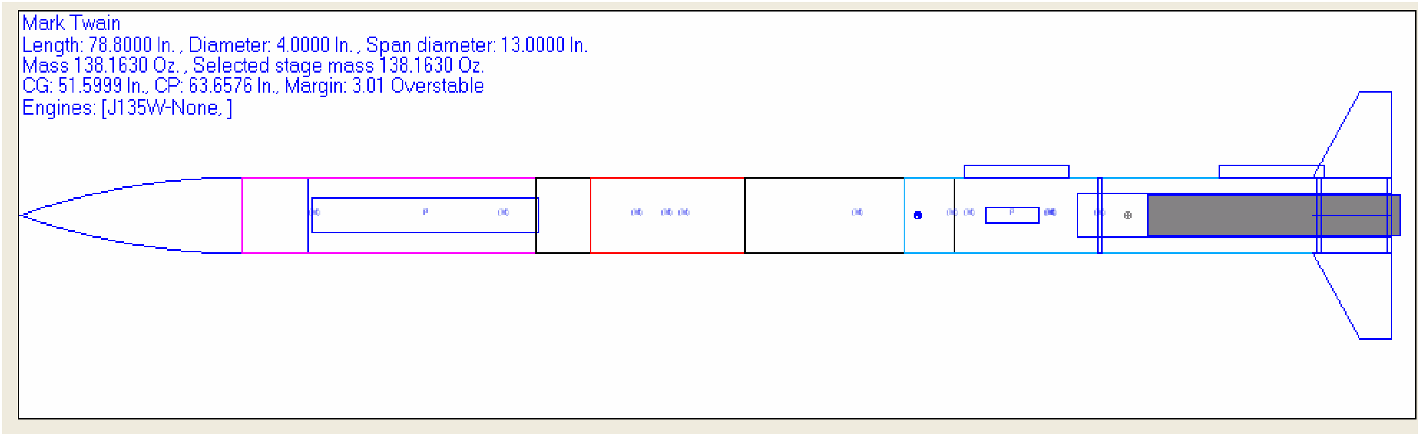
➢ **Review the design at a system level**

a. Main Airframe Subsystem
- Rocket motor- J135
- Fin Section- to hold the motor tube as well as the parachute, deployment charge, and the fins
- Nosecone

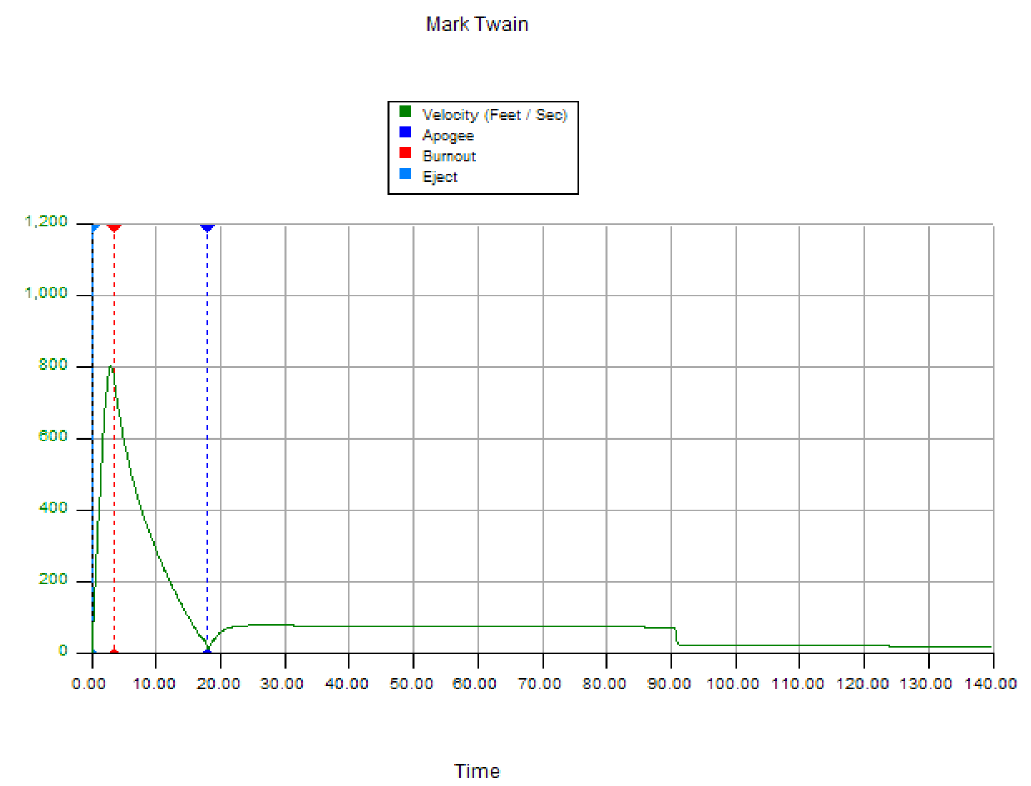
b. Payload Subsystem
- Altimeter- ALTS2- will sense altitude based on air pressure to set off the drogue chute
- GPS- Part of CanSat package- will track rocket to help with recovery
- Ozone Sensor System-will sample ozone levels from an altitude of one mile and below during descent and store the data for post-flight retrieval
- Telemetry- Senses airspeed

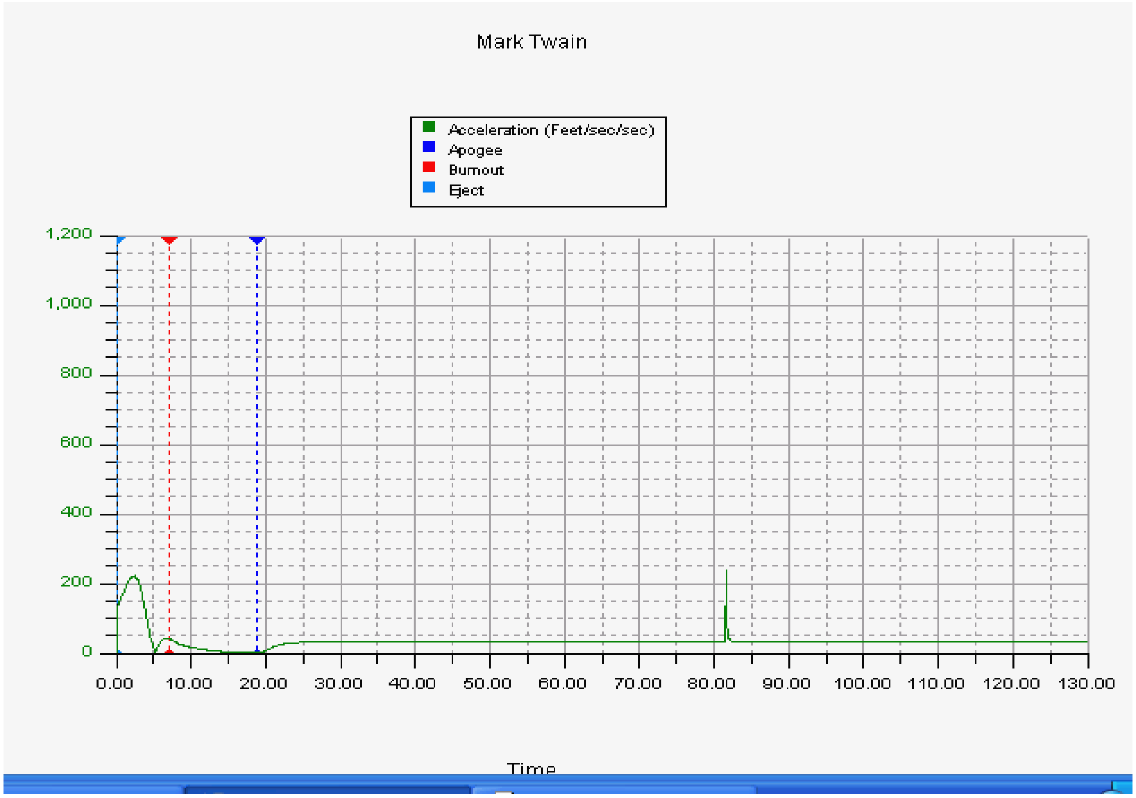
c. Recovery Subsystem
- Deployment charge- Deploys the drogue chute when the altimeter reads the correct altitude
- Main parachute- Slows the rocket for a safe recovery and landing

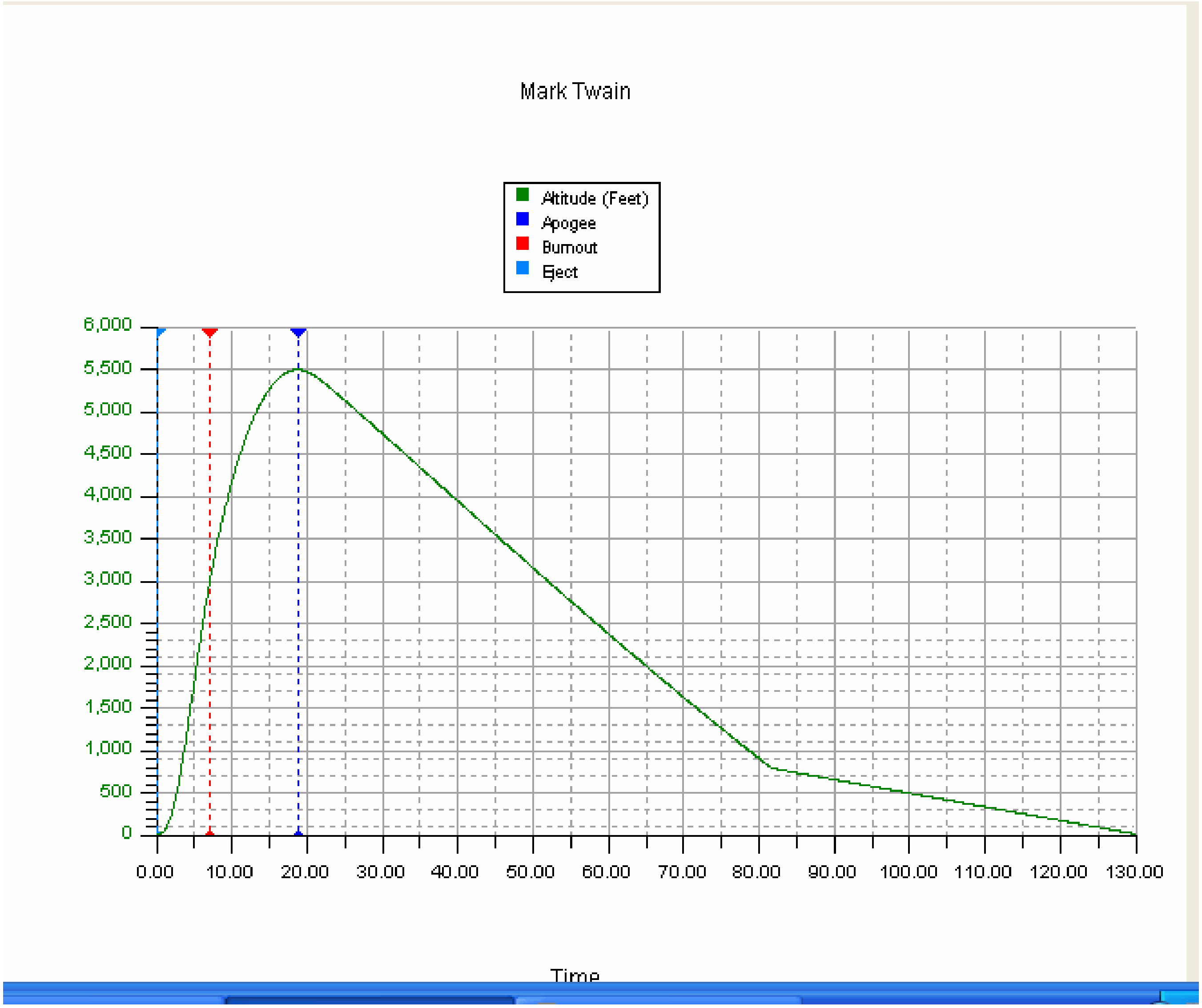
  - Up Dated Drawings and Specifications



- Analysis results







- Preliminary Motor Selection

  Aerotech: J135W
  Diameter: 54.00 mm
  Length: 14.4882 In.
  Burn: 7.00 Sec.
  Total impulse: 11.3.330 N-Sec.
  Average thrust: 157.61 N

- **Demonstrate that the design can meet all system level functional requirements**

  The simulation results show that the rocket will meet the project requirements.

  Mark Twain - Simulation results
  Engine selection
  [J135W-None]
  Simulation control parameters
  Flight resolution: 800.000000 samples/second
  Descent resolution: 1.000000 samples/second
  Method: Explicit Euler
  Launch conditions
  Altitude: 540.00000 Ft.
  Relative humidity: 65.000 %
  Temperature: 62.000 Deg. F
  Pressure: 29.9139 In.
  Wind speed model: Slightly breezy (8-14 MPH)
  Low wind speed: 8.0000 MPH
  High wind speed: 14.9000 MPH
  Wind turbulence: Fairly constant speed (0.01)
  Frequency: 0.010000 rad/second
  Wind starts at altitude: 10.00000 Ft.
  Launch guide angle: 0.000 Degrees from vertical
  Latitude: 90.000 Degrees
  Launch guide data:
  Launch guide length: 72.0000 in.
  Velocity at launch guide departure: 36.8940 ft/s
  The launch guide was cleared at: 0.335 Seconds
  User specified minimum velocity for stable flight: 43.9993 ft/s
  Minimum velocity for stable flight reached at: 101.6004 in.
  Max data values:
  Maximum acceleration: Vertical (y): 302.184 Ft./s/s Horizontal (x): 10.745 Ft./s/s Magnitude: 302.186 Ft./s/s
  Maximum velocity: Vertical (y): 644.3274 ft/s Horizontal (x): 13.0472 ft/s Magnitude: 656.6240 ft/s
  Maximum range from launch site: 1429.18963 Ft.
  Maximum altitude: 5576.87009 Ft.
  Recovery system data
  P: Parachute Deployed at: 87.646 Seconds
  Velocity at deployment: 69.3655 ft/s
  Altitude at deployment: 799.98032 Ft.
  Range at deployment: -586.28937 Ft.
  P: Parachute Deployed at: 18.610 Seconds
  Velocity at deployment: 72.3087 ft/s

Altitude at deployment: 5576.87009 Ft.
Range at deployment: -1429.18963 Ft.
Time data
Time to burnout: 7.001 Sec.
Time to apogee: 18.610 Sec.
Optimal ejection delay: 11.609 Sec.
Time to wind shear: 0.430 Sec.
Landing data
Successful landing
Time to landing: 125.055 Sec.
Range at landing: -150.12927
Velocity at landing: Vertical: -20.9871 ft/s, Horizontal: 0.0000 ft/s, Magnitude: 20.9871 ft/s

- **Specify approach to workmanship as it relates to mission success.**

  Students will take great care in building the rocket. We will all work together on our individual parts and communicate to make sure all parts will fit together. Safety is our utmost concern.

- **Discuss planned additional component testing, functional testing, or static testing.**

  We are going to reduce the air in the chamber until the altimeter reaches around 6000 ft. at this time the altimeter will fire the first charge. Then put back the air until the altimeter reaches 750 ft. and the second charge will fire.
  To test the recovery system, we will put the rocket together and strap down the payload section to a table or a sawhorse. The altimeter will be still being in the vacuum chamber so we can test the parachute recovery system.
  The safe distance will be 10 ft. from the rocket. No one will be to close to it as the charges are set off. The bottom of the rocket will separate from the payload section to its full length of the shock cord. At this time the Ozone data logger will turn on. Then the main parachute will come out of the nose section to its full length. All of this will be supervised by a certified level 3 NAR mentor.

- **Status and plans of remaining manufacturing and assembly.**

  We are in the beginning phases of building the full-scale rocket. The payload components have been ordered but have not been received.

- **Integrity of design**

  - The fins are the correct size according to the scale of the rocket, and they have been rounded to be more aerodynamic.
  - We waste as little as possible when cutting out objects, such as fins and body tube. We ordered and are using aircraft hard plywood to build the fins, bulkhead, and other structural elements.
  - We have a mentor who is a level 3 rocket builder who oversees the construction of the rocket and makes sure we follow proper procedures. We will follow step by step protocol. Making sure all four fins are centered and aligned, the through body tube mount slots are straight and aligned with each other. All fins will have good epoxy fillets, and the launch pin attachment points are epoxyed inside the tube. The load paths will be safely secured.
  - The motor mount will be epoxyed in place with the fins sandwiched in place between the two centering rings and the motor will be held in place by two blind nuts and two screws.
  - If the motor ignites and has the right burn rate to achieve the correct altitude then at apogee the drogue chute will be deployed by altimeter and the ozone sensor will be turned on. The main parachute will deploy at 750 feet.

- **Safety and failure analysis**

KSAT-Student Launch Initiative, Risk Assessment					**Krueger Middle School**
September 23, 2007					**Prepared by: Kirsten Casteel**
Project Phase	**Potential Problem/Hazard**	**RAC**	**Risk Control Options Who-does what-by when?**	**Adjusted RAC**	**Comments-is the control effective?**
Propulsion System testing	**Engine explodes on launch pad;** can injure any one within 400 feet of the rocket from debris or the overall explosion	**EH**	The launch station needs to be at least 400 feet away from the launch pad, spectators need to be at least 500 feet away from the launch pad	**H**	All of our motors are pre-tested so we will not be testing them
Propulsion System testing	**Engine explodes in the air;** can injure any one within 400 feet of the rocket from debris or the overall explosion	**EH**	The launch station needs to be at least 400 feet away from the launch pad,	**H**	All of our motors are pre-tested so we will not be testing them

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			spectators need to be at least 500 feet away from the launch pad		
Propulsion System testing	**Recovery system does not deploy;** can come down very fast, land on someone and cause major injuries	**EH**	The launch station needs to be at least 400 feet away from the launch pad, spectators need to be at least 500 feet away from the launch pad, keep your eyes on the rocket at all times while it is in the air	**H**	All of our motors are pre-tested so we will not be testing them
General Launch procedures	**The rocket can explode on the launch pad;** can injure any one within 400 feet of the rocket from debris or the overall explosion	**EH**	The launch station needs to be at least 400 feet away from the launch pad, spectators need to be at least 500 feet away from the launch pad	**H**	
General Launch procedures	**The rocket can explode in the air;** can injure any one within 400 feet of the rocket from debris or the overall explosion	**EH**	The launch station needs to be at least 400 feet away from the launch pad, spectators need to be at least 500 feet	**H**	

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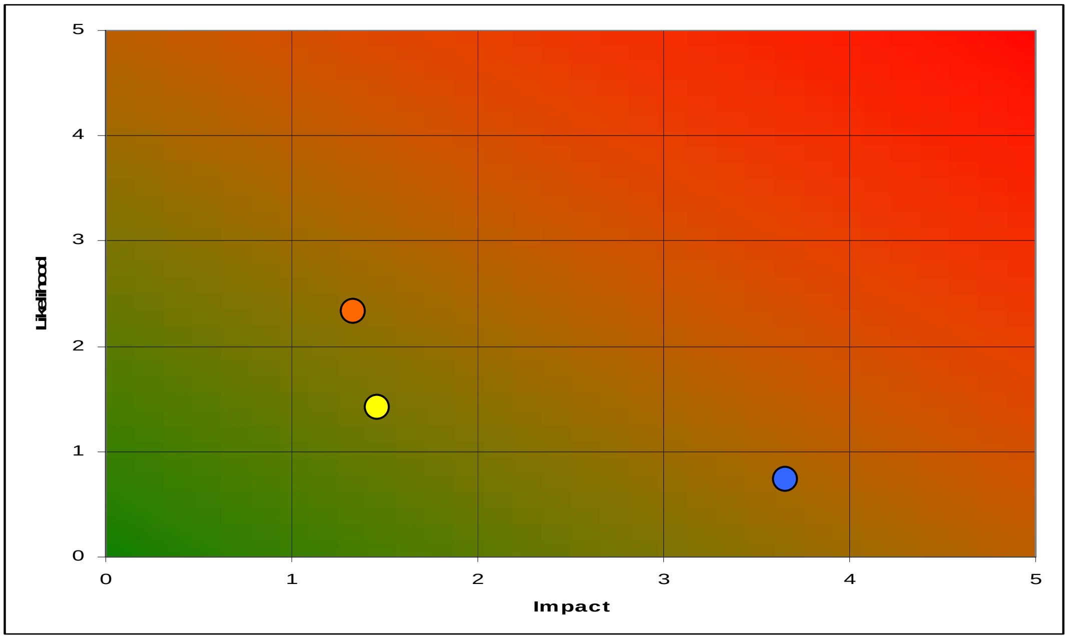
General Launch procedures	**Recovery system on our rocket does not deploy;** can come down very fast, land on someone and cause major injuries	**EH**	The launch station needs to be at least 400 feet away from the launch pad, spectators need to be at least 500 feet away from the launch pad, keep your eyes on the rocket at all times while it is in the air	**H**	

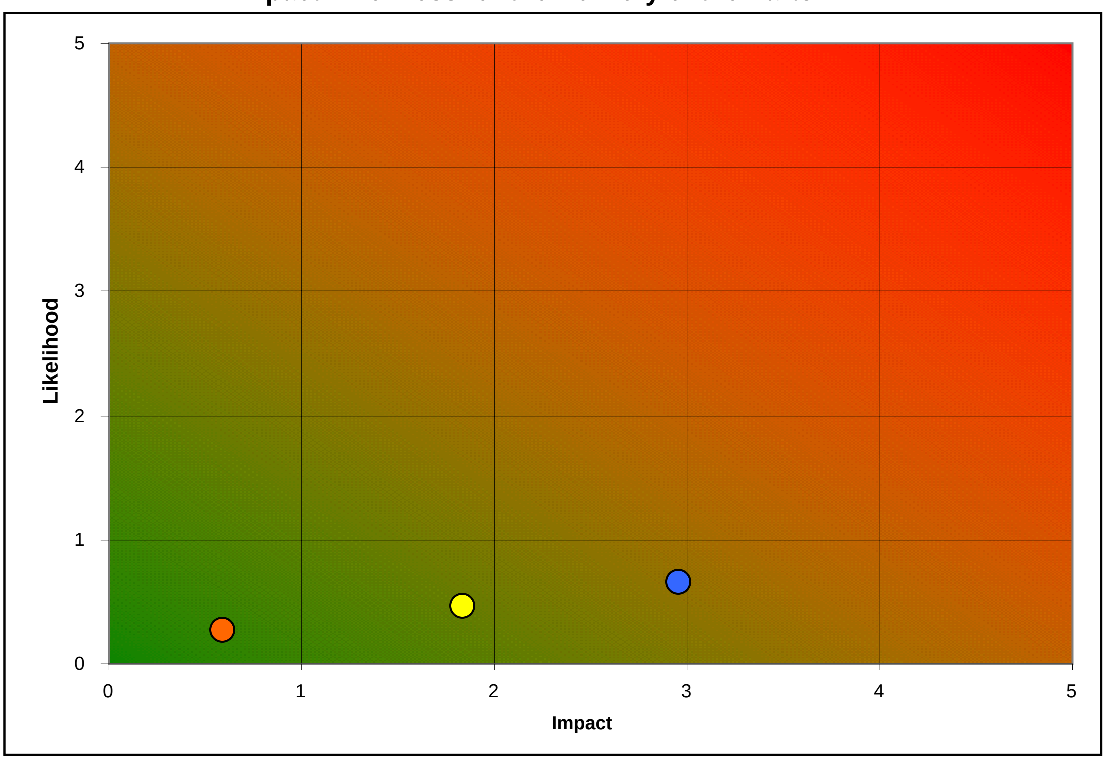
Vehicle Development and Testing Risk Plots

Color Code:
Red - Technical
Blue - Schedule
Yellow - Cost

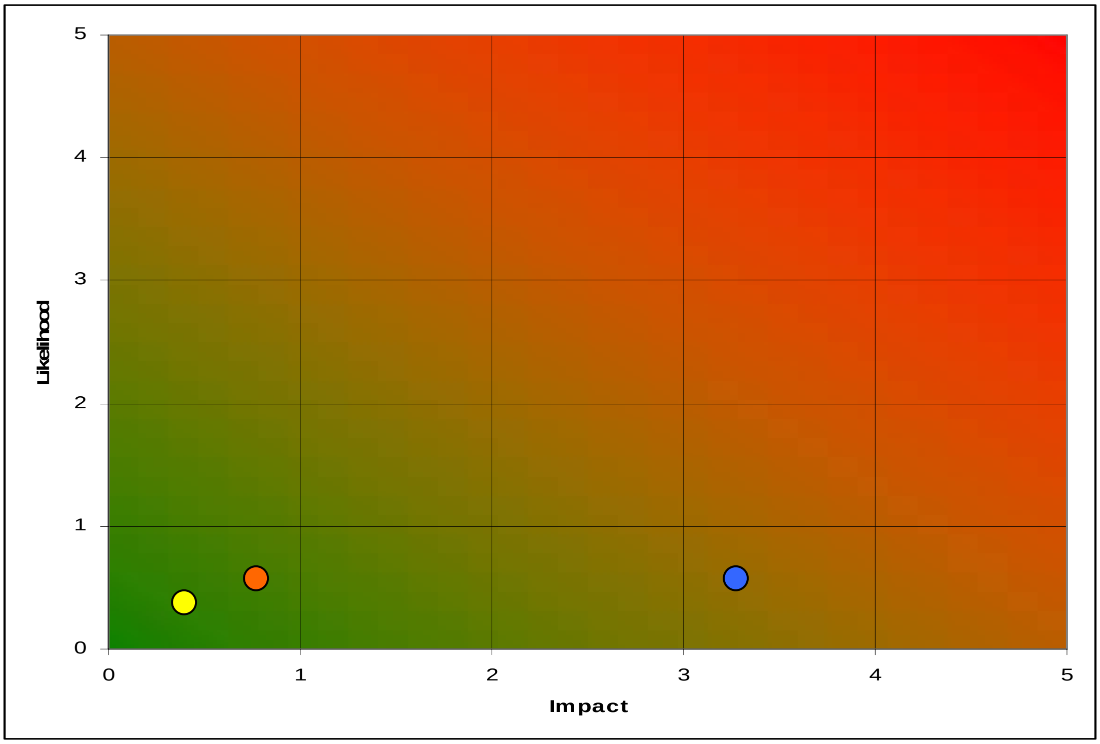
Impact-Likeliness for Rocket Test Failure



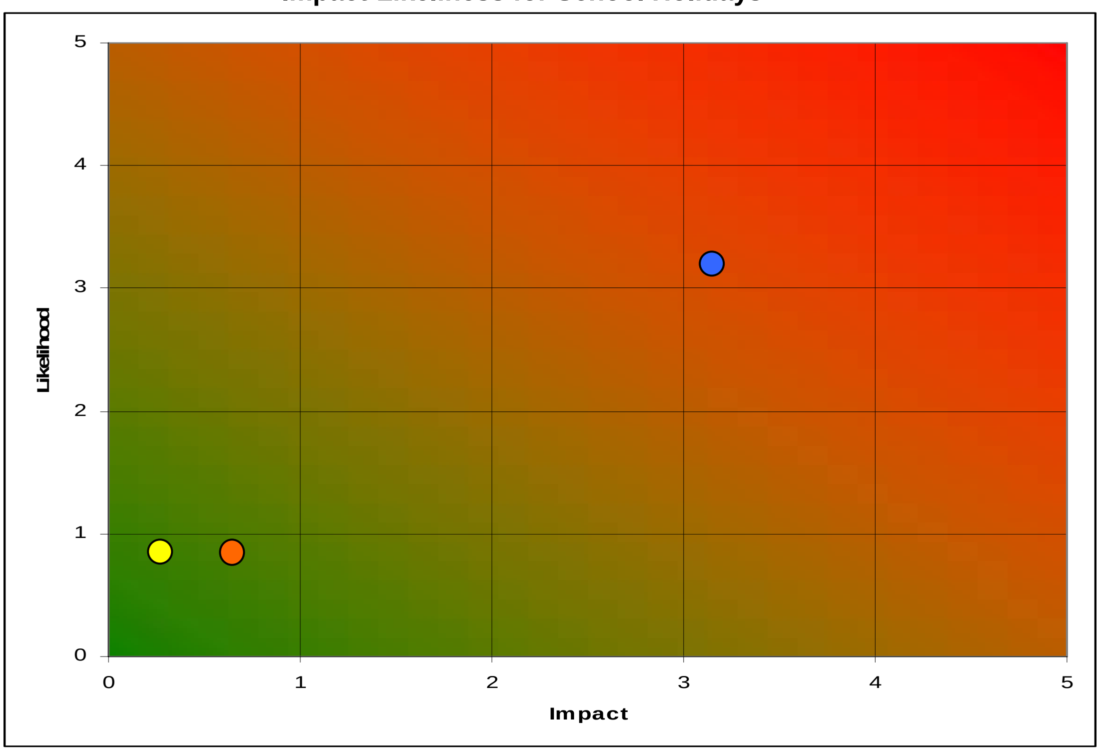
Impact-Likeliness for the Delivery of the Parts



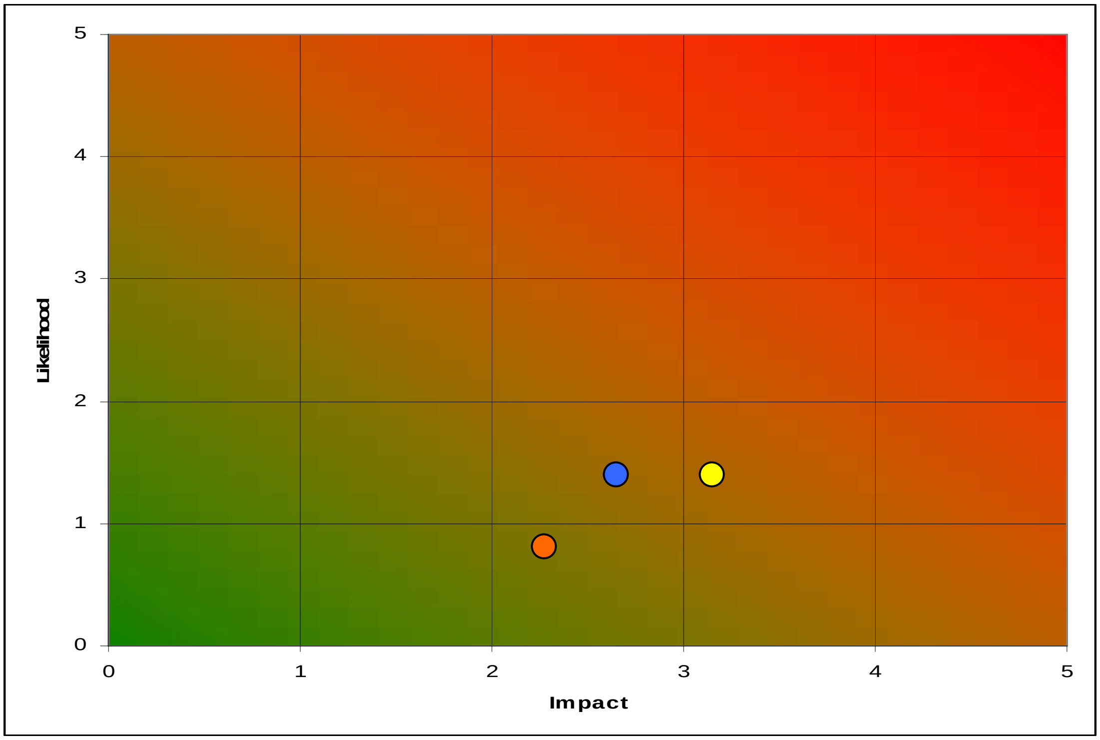
Impact-Likeliness for Inadequate Personnel



Impact-Likeliness for School Holidays



Impact-Likeliness for Budget Costs



Overall Mitigation: Once the team has identified the project completion risk they will plan in advance what will need to happen to prevent project failure.

Recovery Subsystem

- **Suitable parachute size for mass, attachment scheme, deployment process, test results with ejection charge and electronics**

  We will use a duel deployment system with a 32 in drogue parachute and 72 in main parachute. They will be secured with eye bolts and a Kevlar shock cord – 390 in for the drogue and 12 ft for the main parachute.

- **Safety and failure analysis**
  (See above table)

- **Mission Performance Predictions**
  State the mission performance criteria

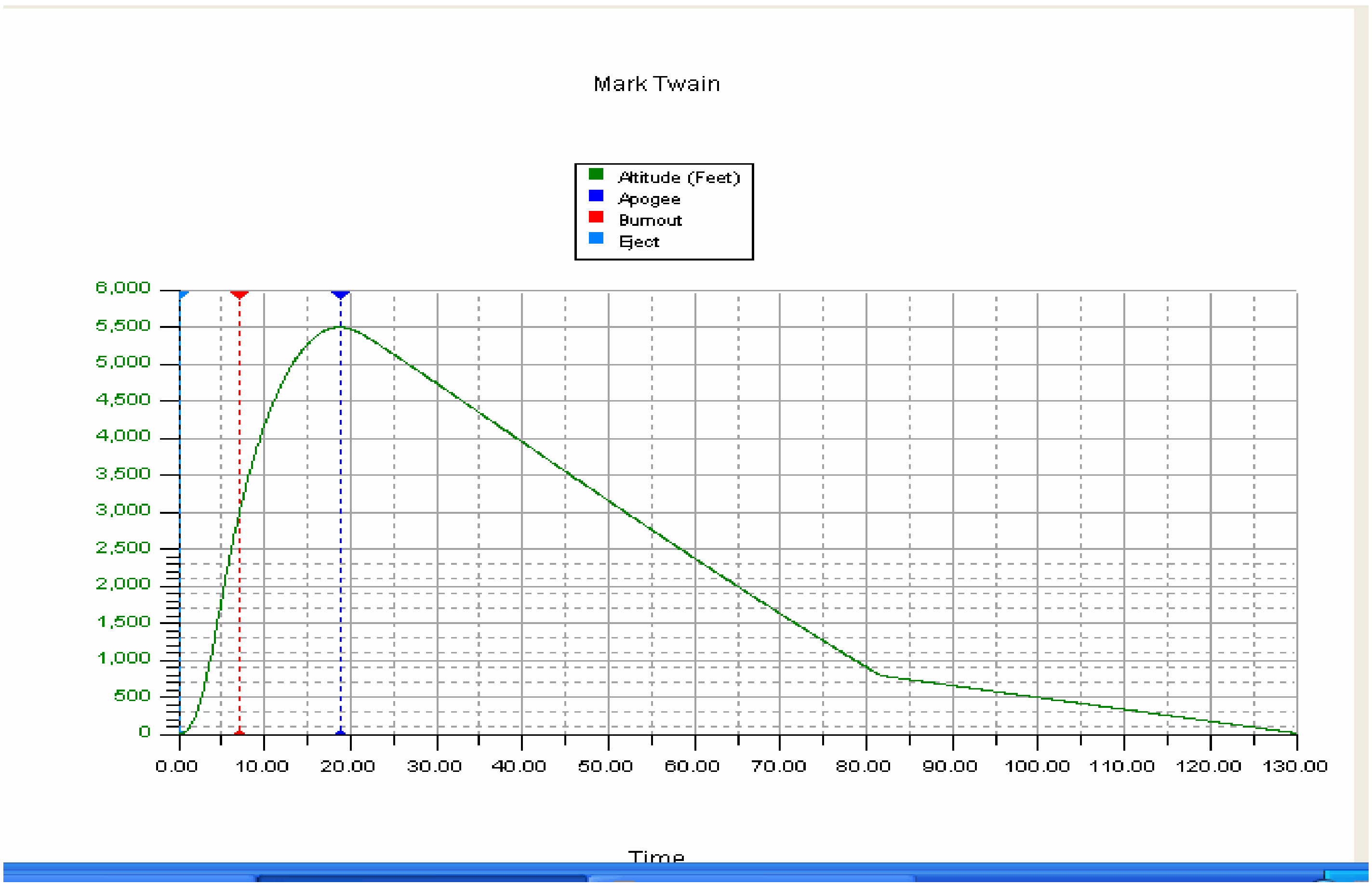
- Rocket will achieve an altitude of 5280 feet (I mile) above ground level.
- The rocket will carry a scientific payload during flight.
- The scientific payload will record and store ozone concentration levels during descent
- The stored data will be retrieved and analyzed once the rocket is recovered post-flight.

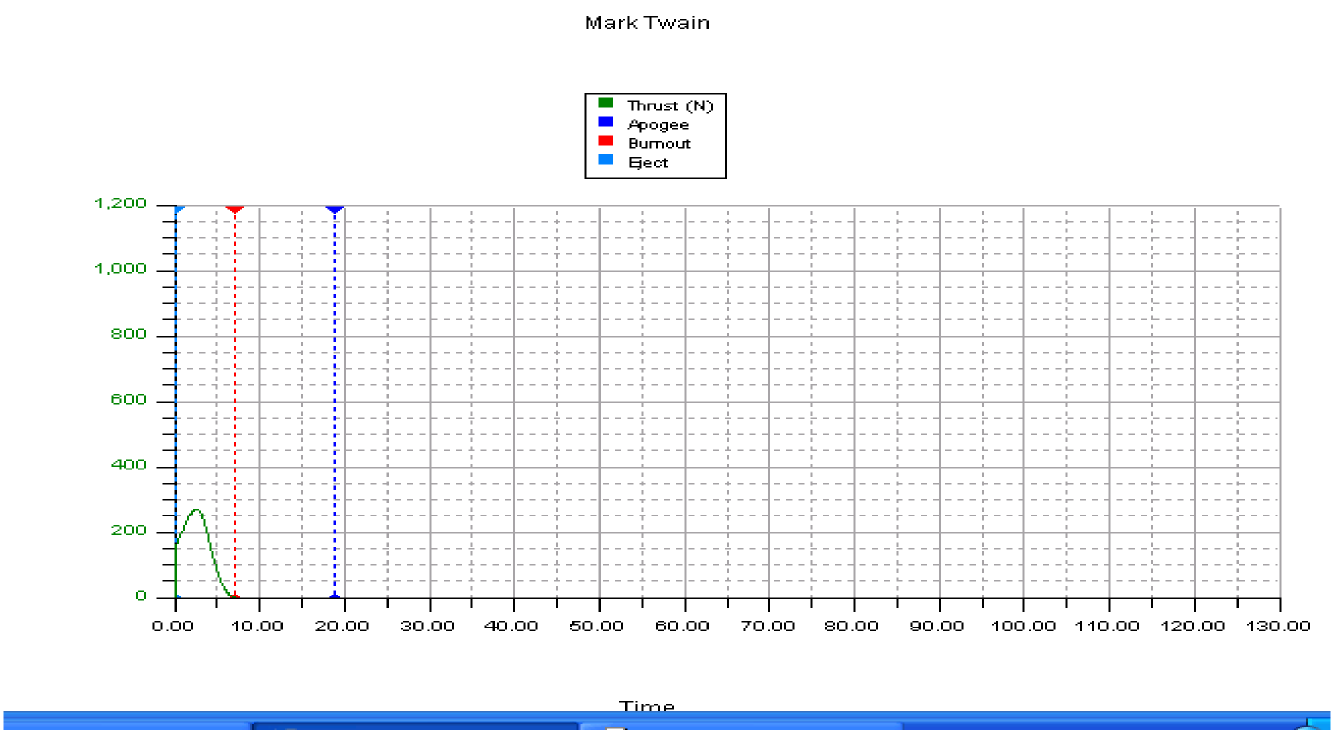
- **Show flight profile simulations, altitude predictions with real vehicle data, component weights, and actual motor thrust curve.**

Mark Twain – Motor Comparison

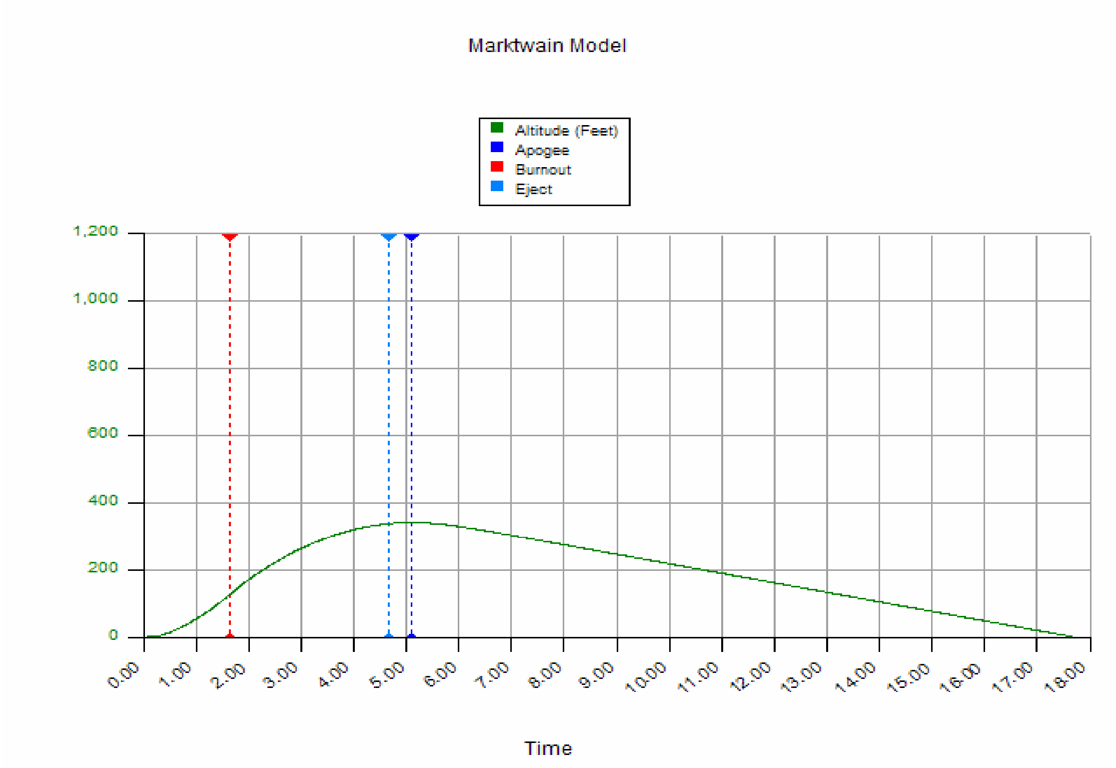
	Simulation	Results	Engines loaded	Max. altitude Feet	Max. velocity Feet / Sec	Max. acceleration Feet/sec/sec	Time to apogee	Velocity at deployment Feet / Sec	Altitude at deployment Feet
1		1	[J135W-None]	5321.52	631.89	574.57	18.40	89.75	5321.52
2		3	[J135W-None]	5183.20	632.16	574.57	18.16	110.91	5183.20
3		5	[J135W-None]	5493.60	631.40	575.40	18.71	50.12	5493.60
4		2	[J180T-None]	4173.92	553.94	574.53	15.78	43.02	4173.92
5		0	[J180T-None]	4170.24	553.92	574.53	15.77	44.42	4170.24
6		4	[J415W-None]	5992.72	804.50	574.57	17.87	30.74	5992.72

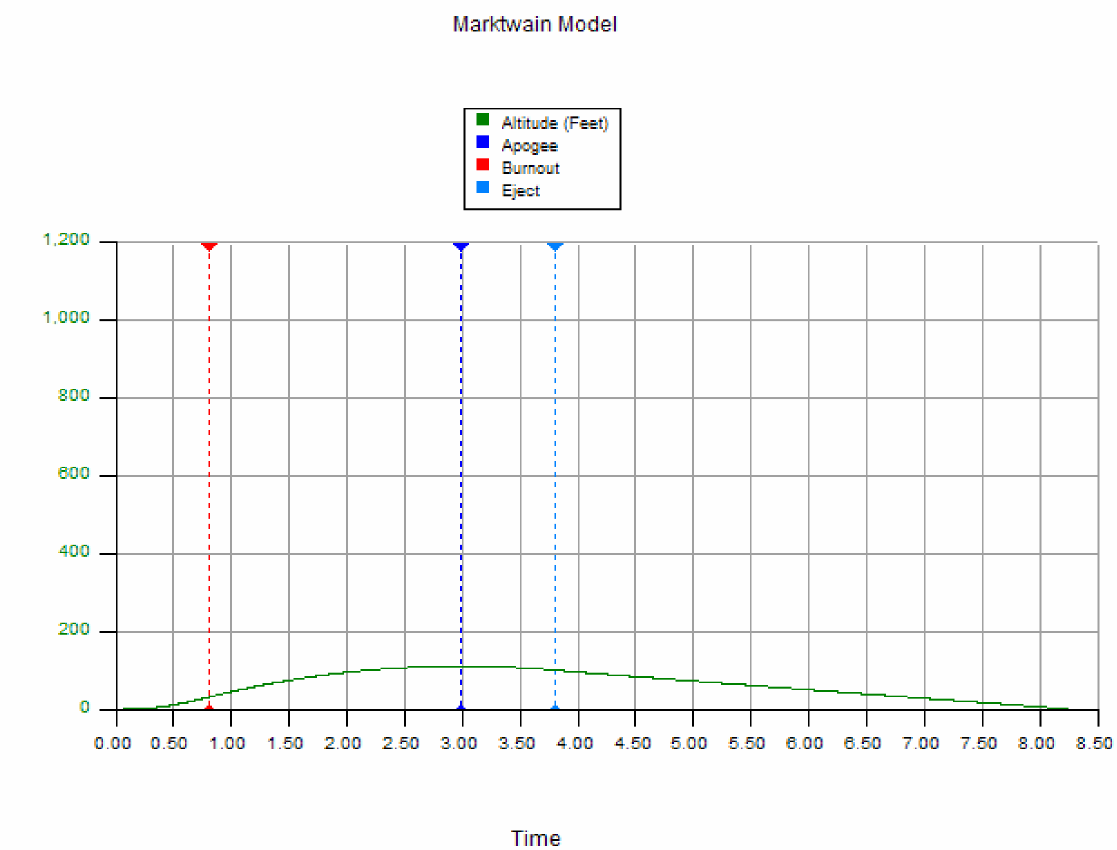
Simulation summary results.



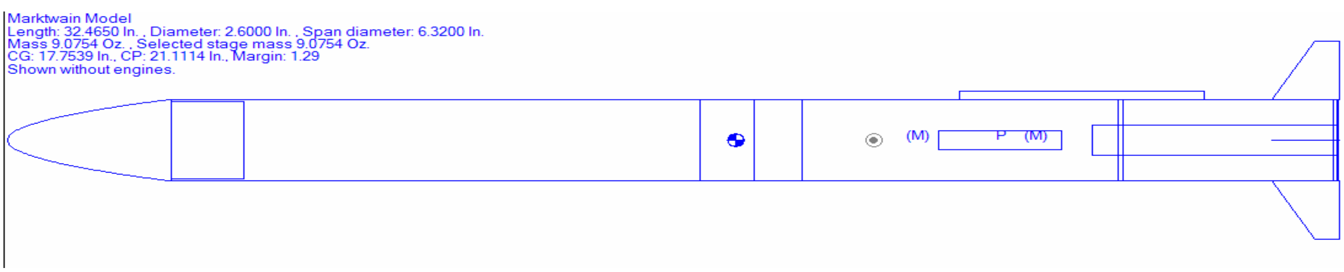


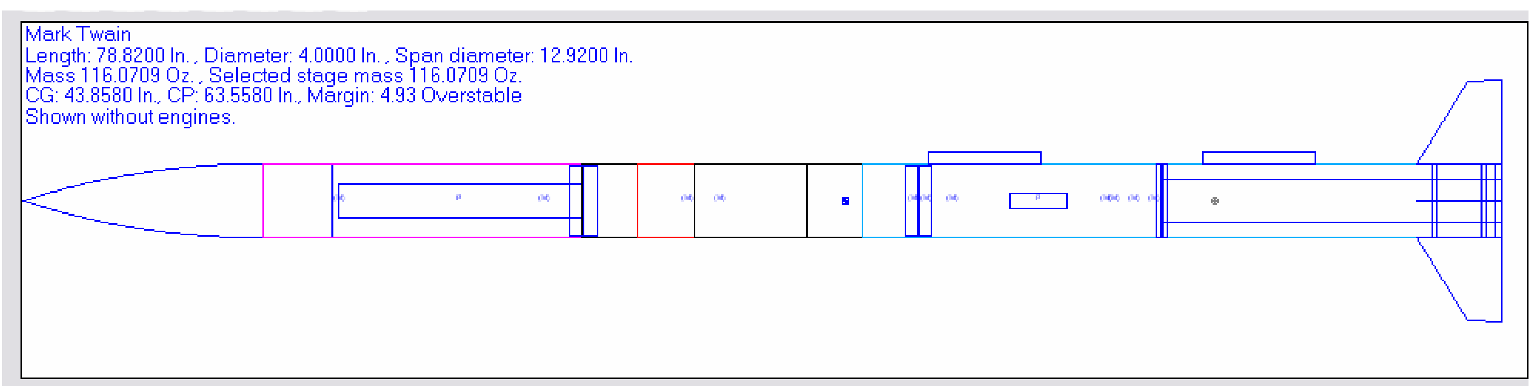
- **Show thoroughness and validity of analysis, drag assessment, scale modeling results**





- **Show stability margin, actual CP/CG relationship and locations**





Payload Integration

➢ **Describe integration plan**

The rocket payloads (control, scientific, and recovery) will be mounted on an assembly designed to slide in and out of the rocket airframe. The assembly will be constructed of wood, fiberglass cloth, and Epoxy will consist of two cylindrical disks at the ends, with a 2-sided, flat mounting surface spanning the length between the ends. The two cylindrical disks will be constructed such that they are snug with the inner diameter of the airframe to prevent movement during flight, but will still be able to be removed as a single unit when disassembling the rocket.

**** Photograph Provided by Ray Kinsel**

The payloads will be mounted to the flat surface using shock mounts to minimize the stresses transmitted to the payloads during lift-off and landing. All electrical interconnects will be secured in a way to provide adequate stress relief while preventing inadvertent disconnects.

Air flow to the ozone sensor will be achieved by a drilling a small hole in the airframe. The hole will also serve as the air pressure source for the altimeter.

Launch concerns and operation procedures

➢ **Submit draft of final assembly and launch procedures**

Propulsion:

- Make sure that rocket motor is assembled correctly
- Make sure that igniter is in place and grounded
- We will use the manufacturer's included instructions when putting the motor together.

Recovery for lower section's
- Make sure that shock cord is attached to all components
- Parachute is wrapped in flame resistant cloth

Altimeter:
- Make sure that batteries are connected and charged
- Verify that it works
- Prep charges
- Ensure that igniters are connected and secured
- Make sure that black powder is packed in place

Ozone sensor:
- Ensure that batteries are secured and fully charged
- Ensure that it is in the correct place
- Ensure that all components are working properly

GPS:
- Ensure that batteries are connected and charged
- Ensure that GPS is connected to a laptop and works

Telemetry package:
- Ensure that batteries are connected and charged
- Ensure that GPS is connected to a laptop and works

Main Parachute:
- Make sure that shock cord is attached to all needed components
- Wrapped in parachute protector

Deployment charge:
- Make sure that ejection charge is connected
- Ensure that black powder is in place

➢ **Set up on launcher**

- Launch rails and launch stand with metal plate for protection

➢ **Trouble Shooting**

What could go wrong	What might have gone wrong	How to fix it
The engine doesn't ignite	1. the igniter was a dud 2. the engine was a dud 3. the electric launch system doesn't work	1. replace the igniter 2. replace the engine 3. replace the battery, turn off the safety, or make sure the leads are hooked up
The parachute doesn't deploy	1. altimeter didn't work 2. wading slipped 3. bound too tight 4. shroud lines were tangled	1. replace the altimeter for next time 2. pack the wading better next time 3. bind it looser next time 4. untangle the shroud lines for next time
Nose cone and body tube separate in air	1. the shock cord broke	1. pack wading around the cord 2. tie tight (if there was a knot) 3. securely glue it

Fins break	1. you dropped the rocket 2. the recovery system messed up 3. the fins weren't glued correctly	1. be more careful 2. see 'the parachute doesn't deploy' 3. use fillets
The rocket flies weird (crooked or otherwise not straight)	1. the fins were crooked or broken 2. the nose cone isn't straight 3. launch rail is crooked 4. the rocket is unbalanced	1. glue them on right 2. take it off and correct it 3. straighten it 4. you might have to rebuild the rocket
Rocket explodes	1. faulty engine	1. get a new engine
Parts fall off	1. they weren't secure	1. secure the parts

- **Post flight inspection**

  We will be retrieving the Ozone sensing results from the Data Logger to analyze the ozone levels at each launch location. We will inspect the rocket for any damage. If, the recovery system fails and the rocket is severely damaged then we will try to determine what caused the mishap.

Safety and Environment (Vehicle)

- **Identify Safety Officer for your team**

  The Krueger SLI team is Kirsten Casteel.

- **Provide a Preliminary analysis of the failure modes of the proposed design of the rocket, payload integration and launch operations, including proposed and completed mitigations.**

  This information is addressed in **Error! Reference source not found.**.

- **Provide a listing of personnel hazards, and data demonstrating that Safety Hazards have been researched.**

  The Krueger SLI team will follow all safety precautions and direction provided in the MSDS sheets for potentially hazardous material used during rocket construction.

  The ozone sensor, which utilizes a heated substrate for ozone sensing, will be enclosed in the original manufacturing packaging. This will prevent team member exposure to a potential burn hazard.

  Additionally, the electrical systems on the rocket use low voltages (9VDC).

- **Update the listing of personnel hazards, and data demonstrating that Safety Hazards have been researched (such as Material Safety Data**

Sheets, operator's manuals, NAR regulations), and that hazard mitigations have been addressed and mitigated.

- The Krueger SLI team will follow all safety precautions and direction provided in the MSDS sheets for potentially hazardous material used during rocket construction. There have been no changes to the listing of personnel hazards because we have not added any new chemicals.

➢ **Discuss any environmental concerns.**

At this time there is a burn ban in affect for several surrounding counties. This has made it difficult to test our scale model rocket. Also, one of our launch sites has been closed until the end of hunting season.
Once the burn bans are lifted and hunting season ends we should be ready to test our rocket. When this occurs we do not anticipate any notable environmental concerns.

IV) Payload Criteria

Testing and Design of Payload Experiment

➢ **Review the design at a system level**

- Payload subsystems

Ozone Sensing

The Ozone sensing system is made up of four major components:

- The OS-4 Ozone Sensor Monitor
- The SM-4 Sensor Module
- The DL-3 Data Logger
- Battery Pack

The OS-4/SM-4 Ozone Sensor system has a range of 0.05-10.0 PPM. It is relatively small and lightweight. The sensor works by heating a substrate made of a semi-conductive material. When the semiconductor heats up, it is sensitive to ozone. The sensor system measures the voltage across the semiconductor. The amount of voltage measured across the heated semiconductor is indicative of the amount of ozone that it is coming into contact with. A key safety feature of the device is that the heated element is flame-arrestor resistant.

Packaging

The ozone sensor system will be packaged into a payload section that can be easily inserted and removed from the rocket body. Each of the system components will be mounted to wood supports inside the section to secure the hardware during flight.

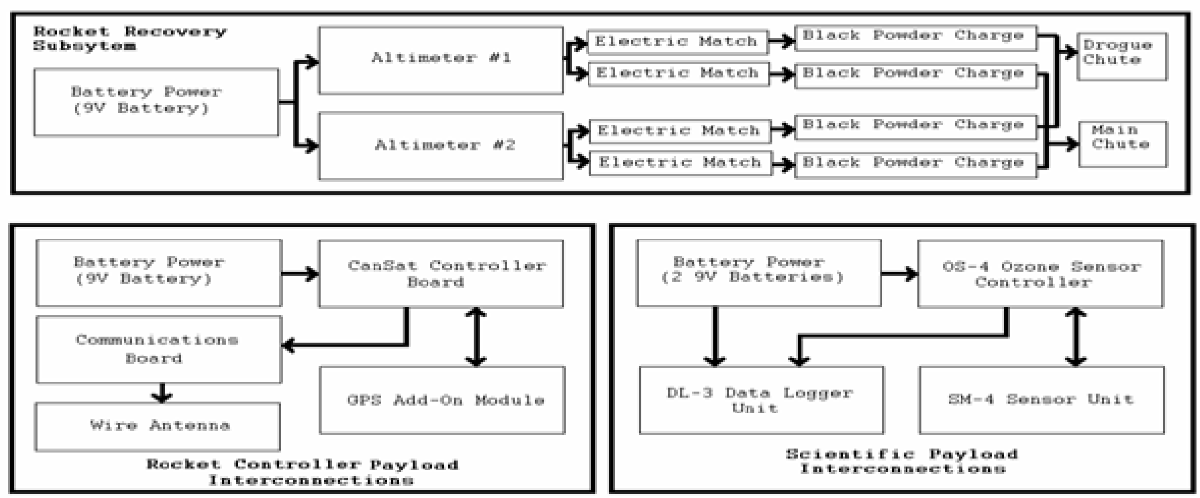
Scientific Payload Control

The OS-4 module provides control for the scientific payload. It interprets the data coming from the SM-4 sensor module and stores the data in the DL-3 data logger. The SM-4 sensing module requires a long warm up period prior to launch.

Data Logging

The data logger will record the data fed to it by the OS-4 sensor monitor, so that the data can be retrieved after the flight. As part of the DL-3, Eco Sensors provides software that will allow the DL-3 to interface to a PC to download the data. Once downloaded, the software also allows for data analysis and reporting. The data logger is 73 X 41 X 59 mm and weighs 140 g. The DL-3 can store over 8,000 readings which will allow for a high level of sampling during flight.

- Drawing



- Analysis results

  The payload components have been ordered from the vendor but have not been received. Compatibility analysis of the system will be conducted upon receipt.

- Test results

  Testing is planned for the payload components after the receipt. The testing will verify system operation.

- Integrity of design

  At this time our team feels confident that the payload design is feasible. Changes will not be considered until the components arrive. Through testing and analysis, the team will determine if changes to the payload subsystems are necessary.

➢ **Demonstrate that the design can meet all system level functional requirements**

CANSAT

1. GPS tracking- will help us find the rocket once it has landed and will give us airspeed.
2. Power pack- will provide power to the systems
3. Telemetry transmitter-will send information to ground computer for graph analysis and location

Ozone Sensor Package

1. OS-4 Ozone Sensor will make continuous measurements of ozone concentrations from one mile high to ground level.
2. DL-3 data logger will start to record sensor readings when the drogue chute is deployed at apogee.

Altimeters

1. Two ADEPT-ALTS2 altimeters (one primary and one secondary) will be used to control deployment of drogue chute and main parachute.
2. Both altimeters will have separate power supply and black powder charges.

- **Specify approach to workmanship as it relates to mission success**

  Students will work with both the payload and rocket mentors during the construction of the payload section. They will pay particular attention to the suggested manufacture instructions provided by both mentors. The students will apply craftsmanship standards that have been taught during their rocketry classes over the past three years. Finally, the students of both the payload and rocket teams will work together during the integration process paying close attention any concerns or needed modifications shared by members of both teams.

- **Discuss planned component testing, functional testing, or static testing**

  Testing of the scientific payload is planned prior to launch

  1. Test Ozone sensor for accuracy and repeatability using an ozone generator

  2. Perform analysis using Original Equipment Manufacturer (OEM) provided dimensions to ensure mounting

  3. Once received, perform a fit check to verify placement

  4. Verify payload is secure in the payload section of the rocket

- **Status and plans of remaining manufacturing and assembly**

  The SLI team has ordered but not yet received the Ozone sensor, Data Logger, and the CanSat Telemetry system. No changes are scheduled to the original assembly plan until the team has had a chance to work with the actual components.

- **Preliminary integration plan**

  The preliminary integration plan of the scientific payload will consist primarily of a layout using the dimensions provided by the OEM. Once the components are received, a fit check will be performed to ensure the feasibility of the designed mounting.

- **Determine the precision of instrumentation, repeatability of measurement and recovery system**

  Testing of the scientific payload is planned prior to launch. Primary tests include accuracy and repeatability tests using an ozone generator in a controlled environment.

Payload Concept Features and Definition

- **Creativity and originality**

  The Krueger SLI team is taking a product not originally meant for a rocket application and integrating it into a scientific payload section mounted in the airframe. The creativity involved in this project is primarily the selection of this particular experiment along with the process of how to successfully integrate the sensor system into the rocket.

- **Uniqueness or significance**

  The Krueger SLI team intends to use the ozone concentration data recovered from the launch to further students' understanding of ozone ground level concentrations in different environments and at altitude.

- **Suitable level of challenge**

  Members on the Krueger SLI team have been involved in rocket development and fabrication for over two years. However, the Krueger SLI team members have never sent a rocket this high with this kind of payload.

Science Value

- **Describe Science Payload Objectives**

  The goal for the scientific payload is to log ozone measurements at different altitudes during descent.

  The team will determine if the levels are different outside a large industrial city and a small rural city.

- **Payload success criteria**

The payload success criterion consists of the following primary objectives:

- Successful integration into the rocket airframe
- Successful initiation of the ozone sensor system upon apogee
- Successful storage of data during descent
- Successful retrieval of data post-flight

- **Experimental logic, approach, and method of investigation**

The Krueger SLI team will analyze the recovered data to investigate the different concentrations of ozone at various altitudes as well as various locations. The team's hypothesis is "If we fly a rocket one mile high to measure ozone concentrations then as the rocket descends the ozone levels should increase." The independent variable in this investigation is the altitude and the dependant variable is the ozone concentration level measured by the ozone sensor. The team will use the same rocket and ozone sensor package for each flight. Ozone readings at ground level will be taken by a separate ozone sensor before, during and after the rocket flight.

The Krueger SLI team will be testing the difference in ozone levels in at least three different places. Tentatively these locations are:

- Krueger Middle School in San Antonio, Texas
- Meeks Ranch in Kerrville, Texas
- The Marshall Flight Center in Huntsville, Alabama.

- **Describe test and measurement, variables and controls**

During each launch, one outside of San Antonio, TX and the other outside of Huntsville, AL the sounding rocket will record ozone levels during the descent phase. Each set of readings will be compared to the actual ground level readings recorded on a separate ozone sensor at the launch site.

Independent Variable: Launch locations
Dependent Variable: Ozone levels from one mile high to ground Level
Control: Each rocket flight will carry the same ozone sensing system and start recording ozone levels at apogee
Experimental Group: Data retrieved from the ozone sensor in the Rocket during each launch
Control Group: Data retrieved from ozone sensor at each launch Site

- **Show relevance of expected data, accuracy/error analysis**

  It is understood that the ozone sensor was not designed to be flown in an atmospheric sounding rocket. Until some actual flight testing can be performed the team is relying on the manufactured specifications which state that the sensor has a range of 0.05 -10 ppm of ozone with its accuracy being 20% depending on the application.

- **Describe the experiment process procedures**

  The team will turn on the ozone sensor on several hours before the actual launch allowing it to warm up.

  The system will be setup for launch and placed in the rocket.

  Once the rocket is launched and achieves apogee the altimeter will fire the drogue chute ejection charge and turn on the data logger.
  The data logger will record the ozone readings during descent.

  The students will retrieve the readings and compare them to the actual flight data provided by the CanSat telemetry system.

  The students will take the readings from both launches and determine if there is a significant difference between launch locations.

  At the same time they will compare the rocket data to the control sensor that will be measuring the actual ozone levels at ground level during the launch.

Safety and Environment (Payload)

- **Identify Safety Officer for your team**

  The Krueger SLI team's Safety Officer is Kirsten (KC) Casteel

- **Update the Preliminary analysis of the failure modes of the proposed design of the rocket, payload integration and launch operations, including proposed and completed mitigations.**

  We have not made any changes or updates to our mitigations since the preliminary design review. Until we have received the actual payload components we will not be able to test, analyze or insure that the components will actually be compatible with the rocket system.

- **Update the listing of personnel hazards, and data demonstrating that Safety Hazards have been researched (such as Material Safety Data Sheets, operator's manuals, NAR regulations), and that hazard mitigations have been addressed and mitigated.**

  We have not made any changes or updates since the preliminary design review.
  There are no environmental concerns at this time.

V) Activity Plan

Show status of activities and schedule

- **Budget plan**

  - The school district signed the initial contract and has mailed it back to MSFC.
  - We have also received and signed the updated contract. We will be mailing it back to MSFC this week.
  - The team has mailed in the first invoice.
  - We have purchased all of the needed materials to build both the rocket and payload.
  - With added support from the school we are going to build two Sounding Rockets. This way if we have any problems this spring at Meeks Ranch while making our first sounding we will have a back up to fly in Huntsville, AL.
  - We are just waiting for all of the materials to arrive so we can finish building the rocket and payload.

- **Timeline**

  There are no changes at this time to our timeline.

- **Outreach summary**

  The students have been invited to assist the recruiting teams who will be visiting several elementary schools this spring. They will provide 5th grade students a brief summary of what to expect during the rocketry classes if they choose to attend our magnet program.
  The students will be going to Longs Creek Elementary School to teach a lesson in rocketry to 5th grade students during their Science Day Program.
  Astronaut John Blaha will be coming to our school to speak to the SLI students and the other magnet school students on March 14th.
  Our SLI program was mentioned in the San Antonio Express Newspaper over the holidays.
  We have received $1,700.00 in donations and have purchased team hats, shirts, and jackets to wear at the various school functions and rocket

launches. We are still actively looking for sponsorships to help support the travel cost for the team this spring.

VI) Conclusion

Overall, we seem to be on track with our budget, timeline, and outreach. We have purchased our rocket parts and have started construction. We are involving the local community and getting donations.